Review

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Sickness absence in Denmark – research, results, and reflections

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Objectives The aim of this paper is to provide an overview of recent research results on sickness absence in a Danish labor market context, as presented at the 53rd Nordic work environment meeting in 2008. The paper focuses on sickness absence predictors, return to work following sickness absence, and long-term consequences of sickness absence. An additional aim is to identify areas for future research and action.

Methods We present 17 longitudinal studies: 11 on predictors of sickness absence (socio-demographic factors, work environment exposures, and health behavior); three on return to work (socio-demographic factors, work environment exposures, and self-efficacy); and three on consequences of sickness absence in terms of future disability pension and mortality risk.

Results The combined use of survey and register data has provided a fundamental overview of the work-related predictors of sickness absence in the Danish working population. Both psychosocial and physical work factors increase the risk of long-term sickness absence, which is furthermore, a greater risk for female employees. The risk associated with the physical work environment at the individual level is greater in work groups with poor management quality. The use of survey and register data has aided in identifying populations (in terms of age, gender, socioeconomic position, and occupation) at high risk of sickness absence, disability pension, and mortality.

Conclusion The studies have filled a gap in Danish and international research regarding work-related predictors of sickness absence and return to work. Further research on sickness absence should aim to utilize data sources developed specifically for such purposes and strive to encompass the individual, organizational, and societal level simultaneously. Workplace-based interventions will probably benefit from addressing both the physical and psychosocial work environment at both the individual and organizational level.

Key terms disability; mortality risk; predictor; return to work; review; sick leave.

Sickness absence from work has considerable negative effects for employees, employers, and society at large. Consequently, sickness absence constitutes a public health problem for, and economic burden on, modern society (1–3). Long-term sick leave, in particular, contributes disproportionately to the economic burden (2, 4–6) and is associated with a reduced probability of return to work and subsequent economic and social deprivation (5, 7–11). Therefore, sickness absence records may provide a useful risk marker for predicting future disability retirements (7, 12) and mortality (13).

Due to demographic trends, indicting an ageing of the population and thus also the workforce, sickness absence and retention of employees has had high priority on the political agenda in Denmark since the start of this millennium. The total annual sick leave is equal to approximately 150 000 workers (ie, about 5% of the total workforce) being absent from work fulltime (14). The Danish government has launched action plans – in 2003 (15) and again in 2008 (16) – to identify actors and define roles and responsibilities in relation to sickness absence and the return-to-work process. At the time of the launch of the first action plan in 2003, the knowledge base on how to proceed was very limited as there were barely any research results describing the topic in a contemporary Danish labor-market setting. As a consequence, the action plan included the allocation of resources to research on sickness absence. This paper is based on the results of one of the research initiatives, namely the merging of existing work environment

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cohort studies with administratively collected data on sickness absence compensation. The present paper is not a systematic review, but rather an overview of research results based on 17 published papers (12, 13, 17–31), all with contributions from the two authors of this paper. It was presented at the 53rd Nordic work environment meeting in Oslo in 2008.

At the initiation of the study, a conceptual framework for work disability (32) was developed in order to provide structure for design and interpretation for the studies (figure 1). This framework was based on international theoretical and methodological research, which has stressed that the impact of risk factors may vary across different phases of the disability process (33–35). The model takes into account the dynamics of the work disability process. It reflects, furthermore, that sickness absence is embedded in a context of different, but overlapping, layers that can be regarded as having an impact on the work disability process (ie, health, work environment, individual characteristics, healthcare system, and socio-economic and political aspects). Disability is defined according to a "social model", which can be distinguished from the medical definition that views disability as a biological characteristic of the individual. The social model is a societal/environmental construct that recognizes the importance of the interaction between the individual and the social and physical environment. Therefore, disability is the inability to perform normal activities or fulfill conventional societal roles. This means that work disability is related to a reduction of task performance and a restriction on one's ability (ie, incapacity) to perform normal work.

The studies adapted a workplace perspective on the disability process; in other words, the focus was on identifying individual and workplace level factors affecting sickness absence. In figure 1, these would be those factors that increase the risk of an individual moving from left to right (from A to B, and from B to C). Healthcare and social system interventions, as well as legislative effects, were not assessed.

Methods

Survey and register data

All 17 studies are based on data from a national register on social transfer payments and three work environment cohorts: (i) the Register-Based Study of Marginalization (DREAM); (ii) the Danish Work Environment Cohort Study (DWECS); (iii) the Intervention Project on Absence and Wellbeing (IPAW); and (iv) the Healthcare Worker Study (SOSU).

The unique Central Person Registry (CPR) number, assigned to every citizen in Denmark, makes it possible to link the interview-based cohort data with the DREAM register data on social transfer payments.

Register-Based Study of Marginalization (DREAM)

DREAM is a national register on social transfer payments and contains information on all social transfer payments to citizens in Denmark since mid-1991, including all compensation granted for sickness absence since 1996. The type of social transfer payment is reported per week for each person. DREAM includes approximately 3.3 million people and is updated every three months. The register is further supplemented with information on ethnic background, marital status, town of residence, unemployment insurance fund membership, immigration, transition to old-age pension, and mortality. The weekly information on transfer payments is registered if a person

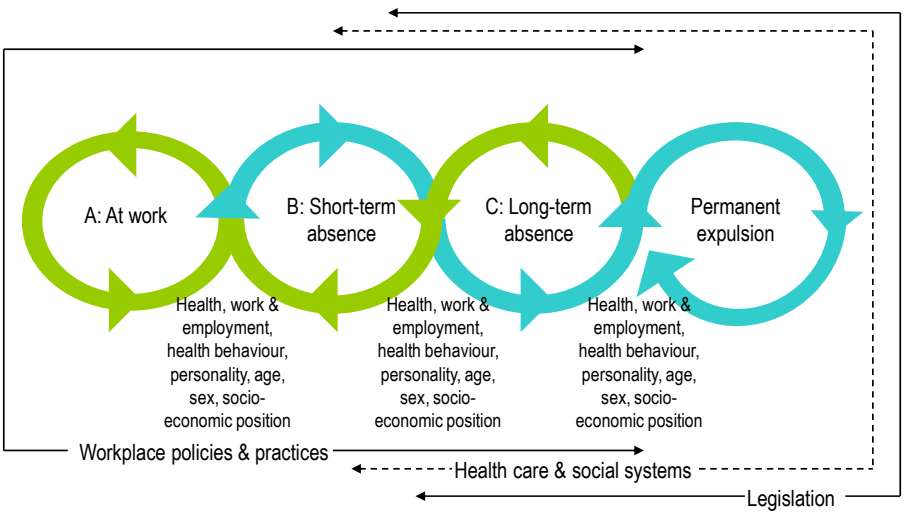

Figure 1. Conceptual framework.

has received any kind of transfer payment for more than one day. It is possible to register only one weekly type of information on transfer payment; if more are registered, the system will, in some cases, overwrite the codes when it is updated. Sickness absence compensation always has the higher priority. Most employees in Denmark receive full wage during sickness absence. The state provides compensation to employers who apply for a refund for sick employees who have been absent for at least two weeks, providing the individual has been employed for eight consecutive weeks prior to the sickness absence and worked for at least 74 hours during this period. Employees not covered by full wages during sickness absence are eligible for sickness absence compensation from the municipality if he or she has been employed for at least 13 consecutive weeks prior to sickness absence and has worked for at least 120 hours during this period. Exceptions to this rule can be made if the employee is a member of an unemployment insurance fund, has completed vocational training of at least 18 months within the last month, or is a trainee.

Danish Work Environment Cohort Study (DWECS)

DWECS featured three panels: 1990, 1995, and 2000. The interviews included questions about work environment exposures, age, gender, education, family status, and health behavior (36).

Intervention Project on Absence and Wellbeing (IPAW)

IPAW included a sample from 52 worksites (clusters) with 2730 employees. All 52 worksites belonged to one of three organizations: (i) a major pharmaceutical company, (ii) municipal workplaces in the care sector, or (iii) the technical services of the municipalities. The baseline questionnaire was sent to the participants between May 1996 and April 1997. The level of education and social status was generally low, 63% of the respondents were skilled, semi-skilled, or unskilled workers. A more detailed description on the rationale, design, study population, and measurements of IPAW can be found elsewhere (37, 38).

Healthcare Worker Study (SOSU)

Data on work environment exposures, especially work schemes, were collected in 2004–2005. The study population consisted of 10 028 female carers of the elderly with the following job titles: (i) social and healthcare assistants, (ii) social and healthcare helpers, (iii) nursing home assistants, (iv) nursing aides, and (v) homecare helpers.

All 17 studies were designed as prospective cohort studies, utilizing appropriate regression models according to the type of data involved.

Results

This section summarizes the results of 17 studies performed and published since the initiation of the first governmental sickness absence action plan in 2003: 11 papers on predictors of sickness absence (17–27), three papers on return to work (28–30), and three papers on the consequences of sickness absence (12, 13, 31).

Sickness absence

The studies (17–24) provided estimates for the risk of sickness absence according to age, gender, and occupation (see table 1, only data from 8 studies presented) (17). Sickness absence is unevenly distributed in the Danish working population, as 20% of the population account for 80% of the absence (data not shown) (25). This is especially evident when studying the distribution across social strata, where studies have revealed a five-fold increase in risk between low and high socioeconomic position. Approximately half of this difference can be explained by differences in work environment exposures (data not shown) (26). With regards to physical work environment exposures and risk of sickness absence, men and women showed identical risk profiles (18). This was not the case with regards to psychosocial exposures – women tended to have increased sickness absence risk if exposed to factors reflecting interpersonal relations at the workplace, whereas men were more prone to sickness absence when exposed to high emotional demands (19). For women, interactions between psychosocial and physical work environment factors were found (18). Similar interaction effects were found between physical exposures on the individual level, and management quality assessed on the workgroup level (20). Effects of various work schemes have also been studied. In a study among the general population, no associations were found between shift work and sickness absence (21), whereas evening work among female carers of the elderly significantly increased the risk of sickness absence (22). Poor mental health among employees increased the risk of sickness absence (23) as did current and former smoking. There were no associations with other health behavior variables (eg, alcohol consumption, obesity, and leisure time physical activity) (24).

In their study on health behavior, Christensen et al (24) calculated the etiological fraction for the risk of sickness absence attributable to smoking. Attributable fractions have also been calculated for work environments exposures; after mutual adjustment, no significant effect of psychosocial work environment factors remained. In men, 23% and 28% of long-term sickness absence were attributable to working mainly standing or squatting, and

Table 1. Overview of statistically significant (P<0.05) results of studies on sickness absence. (PPR = prevalence proportion ratio, HR = hazard ratio, OR = odds ratio, EF = etiological fraction)

Study	Main risk factors	Co-variates	Outcome, design & analysis	Significant (P<0.05) associations
Lund et al, 2007 (17)	Age, gender, education, employer size, employer ownership, job group (12 groups), business sector (11 sectors)	None; all estimates for main determinants are unadjusted	Onset of sickness absence periods of ≥8 weeks during a 30 month follow-up; prospective cohort study of 5357 employees; logistic regression	Female gender (PPR=1.36); age 40–49 years (PPR=1.68); no post school education (PPR=3.68); municipal employer (PPR=1.75); kindergarten teachers/daycare jobs (PPR=1.80); healthcare jobs (PPR=1.41); cleaners, janitors and kitchen staff (PPR=1.63); unskilled workers (PPR=1.40); managers (PPR=0.61); computer pros/technicians/designers (PPR=0.37); professionals (PPR=0.26); the health care/ social work sector (PPR=1.63); private administration sector (PPR=0.55)
Lund et al, 2006 (18)	Physical work environment (5 indices)	Age, education, family status, chronic disease, health behavior and psychosocial factors (13 scales)	Onset of sickness absence periods of ≥8 weeks during an 18 month follow-up; prospective cohort study of 5033 employees; Cox regression	**Women:** extreme bending/twisting of neck/back (HR=1.21), working mainly standing/squatting (HR=1.31), lifting/carrying loads (HR=1.27)m, pushing/pulling loads (HR=1.20); **Interactions physical × psychosocial factors**: extreme bending/twisting of neck/back × high emotional demands (HR=1.14), working mainly standing/squatting × role conflict (HR=1.17), Lifting/carrying loads × role conflicts (HR=1.15); **Men**: extreme bending/twisting of neck/back (HR=1.41), working mainly standing/squatting (HR=1.54), lifting/carrying loads (HR=1.51), pushing/pulling loads (HR=1.28)
Lund et al, 2005 (19)	Psychosocial work environment (13 scales, 1 single item question)	Age, education, family status, chronic disease, health behavior and physical exposures (3 indices)	Onset of sickness absence periods of <8 weeks during an 18 month follow-up; prospective cohort study of 5141 employees; cox regression	**Women**: management quality (HR=0.84), role conflict (HR=1.23), reward (HR=0.83); **Men**: emotional demands (HR=1.21), hide emotions (HR=1.21)
Labriola et al, 2006 (20)	Physical (6 measures) and psychosocial (7 measures) work factors	Age, family status, organization, intervention assignment, smoking status, alcohol consumption, body mass index, attitude to absence	Onset of sickness absence periods of ≥8 weeks during a 30 month follow-up; prospective cohort study of 1610 employees at 52 workplaces belonging to 3 organizations (a major pharmaceutical company, municipal workplaces in the care sector, or technical services of the municipalities); multilevel logistic regression	**Individual level**: stooping work position (OR=1.20), twisting the back (OR=1.33), pushing/pulling heavy loads (OR=1.15), physical activity in work (OR=1.43), low decision authority (OR=2.17), low supervisor support (OR=2.04), low management quality (OR=1.75); **Workplace level**: low decision authority (OR=2.17), low supervisor support (OR=2.04), low management quality (OR=1.75); **Interactions** (OR for combined effects): twisting × management quality (OR=2.94), pushing/pulling × management quality (OR=3.08), lifting × management quality (OR=3.82), physical activity × management quality (OR=3.22)
Tüchen et al, 2008 (21)	Shift work (irregular working hours, 2-shift systems, fixed evening shifts, 3-shift systems or fixed nights versus permanent day work)	Age, education, health behavior, psychosocial and physical; work environment factors	Onset of sickness absence periods of (i) ≥2 weeks and (ii) ≥8 weeks during a 18 month follow-up; prospective cohort study; Cox regression	No statistically significant associations in fully adjusted models
Tüchen et al, 2008 (22)	Evening work (often between 14.00–23.00)	Age, family status, lifestyle, general health, and work environment factors	Onset of sickness absence periods of (i) ≥2 weeks and (ii) ≥8 weeks during a 18 month follow-up; prospective cohort study of 5627 female carers of the elderly; Cox regression.	Evening work (RR=1.29 for sickness absence ≥2 weeks)
Bültman et al, 2008; (23)	Depressive symptoms (MHI-5)	Age, education, family status, health behavior, chronic disease	Onset of sickness absence periods of ≥8weeks during a 18 month follow-up. Prospective cohort study of 4747 employees; Cox regression.	**Women**: severe depressive symptoms (HR=2.27); **Men**: severe depressive symptoms (HR=2.69)
Christensen et al, 2007 (24)	Health behavior (smoking, alcohol consumption, leisure time physical activity, body mass index)	Age, education, family status, socio-economic position, chronic disease, physical (5 indices) and psychosocial (13 scales) work factors	Onset of sickness absence periods of ≥8 weeks during a 18 month follow-up; prospective cohort study of 5020 employees; Cox regression.	**Women**: ex-smokers (HR=1.61), heavy smokers (HR=2.05), smoking (EF=25%); **Men**: heavy smoker (HR=1.55), smoking (EF=17.4%)

lifting or carrying loads, respectively. In women, 27% of long-term sickness absence was attributable to bending or twisting of the neck or back (data not shown) (27). Calculations have illustrated that the difference in overall work environment exposure level can explain approximately 40% of differences in sickness absence risk (data not shown) (25).

Return to work

Return to work following sickness absence has been the subject of three studies (28–30) (table 2). Female gender, increased age, and low educational level are factors found to be associated with increased "time to return to work". Employer characteristics also played a role, as "time to return to work" was longer at public-owned and larger workplaces. Certain physical and psychosocial factors also prolonged the duration of absence (28, 29). Personality factors, measured in terms of self-efficacy, showed no association with "time to return to work" (30).

Consequences of sickness absence

The consequences of sickness absence, in terms of increased risk of future disability pension and mortality, have been covered in three studies (12, 13, 31) (table 3). One found a 2.5 fold risk of future disability pension for those reporting more than six days of sickness absence per annum at baseline, when taking into account gender, age, socioeconomic position, health behavior, and the physical and psychosocial work environment (31). Another study, utilizing register data in a total population study, found a strong graded association between increased duration of absence and increasing risk of future disability pension (12). Significant differences were found between the younger and older age strata – men <40 years experiencing >26 weeks of sickness absence had a 16-fold risk of disability pension. The corresponding figure for men ≥40 years was approximately 7. For women, the corresponding figures were 12.6 and 6.7, respectively (12).

Among women and blue-collar workers, there was no association of mortality with duration of sickness absence <6 weeks. However, employees with >6 weeks of absence, compared to those with a one week absence, had a substantial excess risk of death in all groups [adjusted hazard ratio 2.2, 95% confidence interval (95% CI) 1.8–2.7]. For women, the hazard ratio was 2.1 (95% CI 1.8–2.4); for men the hazard ratio was 3.7 (95% CI 1.9–7.2) in white-collar occupations, 3.3 (95% CI 2.2–5.0) in intermediate grade occupations, and 2.0 (95% CI 1.7–2.3) in blue-collar occupations (13).

Table 2. Overview of statistically significant (P<0.05) results of studies on return to work following sickness absence. (HR = hazard ratio, OR = odds ratio, RR = risk ratio)

Study	Main risk factors	Co-variates	Outcome, design & analysis	Significant (P<0.05) associations
Lund et al, 2006 (28)	Age, gender, family status, physical (3 indices) and psychosocial (13 scales, 1 single item question) work factors, workplace size and ownership, health behavior (4 measures)	Sociodemographic factors mutually adjusted and adjusted for health behavior. Health behavior factors mutually adjusted and adjusted for sociodemographic factors. Employer characteristics and work factors adjusted for sociodemographic factors and health behavior	"Time to first return to work", defined as time to cessation of sickness absence compensation for at least one week in one year after the onset of a period of sickness absence >2 weeks. Prospective cohort study of 930 sick-listed employees. Cox regression.	Females (HR=0.74); age (HR=0.86 per 1 year increase); no education versus all others (HR=0.78); public employer (HR=0.83); 20–100 versus <0 employees (HR=0.86); ≥100 versus <20 employees (HR=0.86); high emotional demands (HR=0.90); high job insecurity (HR=0.93); sedentary work (HR=0,93)
Labriola et al, 2006 (29)	Physical (7 measures) and psychosocial (8 measures) work factors	Age, family status, organization, intervention assignment, smoking status, alcohol consumption, body mass index, attitude to absence	(i) Return to work within 4 weeks after sickness absence periods of ≥2 weeks during a 12 month follow-up (ii) return to work within 4 weeks after sickness absence periods of ≥2 weeks during a 12 month follow-up (iii) duration of sickness absence periods of ≥2 weeks during a 12 month follow-up Prospective study of 427 employees, multilevel logistic & poisson regressions	**Individual level**: low meaning of work (OR=0.67), stooping work position (OR=0.71), twisting the back (OR=0.75), repetitive job tasks (OR=0.74) **Individual level**: stooping work position (OR=0.68), repetitive job tasks (OR=0.64) **Individual level**: low decision authority (RR=1.15), low meaning of work (RR=1.25), lifting more than 30 kg (RR=1.29), pushing/pulling heavy burdens (RR=1.18)
Labriola et al, 2007 (30)	Self-efficacy (3 items – self-esteem)	Age	Onset of sickness absence periods of ≥2 weeks, return to work defined as cessation of sickness absence benefits after sickness absence periods of ≥2 weeks during a 12 month follow-up; cross-sectional and prospective cohort study of 930 sick-listed employees; cox regression	Those sick-listed at baseline had lower self-efficacy (mean=75.1) than those working (mean=82.9); among those working at baseline, self-efficacy showed no association with sickness absence or subsequent return to work

Table 3. Overview of statistically significant (P<0.05) results of studies on consequences of sickness absence. (HR = hazard ratio; OR = odds ratio)

Study	Main risk factors	Co-variates	Outcome, design & analysis	Significant (P<0.05) associations
Lund et al, 2008 (12)	Duration of sickness absence assessed during a 12-month period	Age	Mortality in a 48-month period beginning 24 months after the sickness absence assessment period; prospective study of 236 207 private sector employees with sickness absence divided into 3 occupational grades (blue-collar, intermediate and white-collar); Cox regression	**Women**: ≥6 versus 1 week (mortality rate=3.68, HR=2.23) **Men**: ≥6 versus 1 week (mortality rate=5.18, HR=2.08), 4–5 versus 1 week (mortality rate=3.39, HR=1.36), 3 versus 1 week (mortality rate=3.43, HR=1.39), 2 versus 1 week (mortality rate=3.02, HR=1.22) **Blue-collar**: ≥6 versus 1 week (mortality rate=4.95, HR=1.95), 3 versus 1 week (mortality rate=3.49, HR=1.30) **Intermediate**: ≥6 versus 1 week (mortality rate=5.09, HR=3.27), 4–5 versus 1 week (mortality rate=3.58, HR=2.33), 3 versus 1 week (mortality rate=2.88, HR=1.92), 2 versus 1 week (mortality rate=2.61, HR=1.86); **White-collar**: ≥6 versus 1 week (mortality rate=6.88, HR=3.65)
Lund et al, 2009 (13)	Duration of sickness absence assessed during a 12-month period	Age	Receiving disability pension in a 48-month period beginning 24 months after the sickness absence assessment period. Prospective study of 225 056 private sector employees with sickness absence. Cox regression	**Women**: 4 versus 1 week (HR=1.44), ≥26 versus 1 week (HR=6.65), interaction duration × age P<0.0001; **Men**: 3 versus 1 week (HR=1.42), ≥26 versus 1 week (HR=7.57), interaction duration × age P<0.0001
Labriola & Lund, 2007 (31)	Accumulated days of sickness absence during a 12 month period; absence days divided into quartiles	Age, (gender), socioeconomic position, health behavior, physical and psychosocial work environment	Receiving disability pension in a 132-month period beginning 36 months after the sickness absence assessment period; prospective study of 4177 employees; logistic regression	**Women**: >6 versus 0 days of absence (OR=2.19); **Men**: >6 versus 0 of absence (OR=3.13); **Total**: >6 versus 0 days of absence (OR=2.51)

Discussion

The combined use of survey and register data has provided a fundamental overview of the work-related predictors of sickness absence in the Danish working population and aided in identifying high risk populations for sickness absence, disability pension, and mortality.

Methodological and theoretical aspects

The following section addresses certain aspects regarding study design and methods that should be taken into account when interpreting the results.

Design. According to a review of sickness absence and disability pension research, the majority of studies performed and reported in international literature suffer from severe methodological deficiencies when it comes to causality, selection, and confounder control (39). The use of longitudinal, as opposed to cross-sectional, designs improves the likelihood of drawing conclusions on causal relations or at least ensures that certain statistical associations can be understood in a causal manner (40). Two observations are adequate for studying individual processes and can provide information about change over time: "Two waves of data are still better than one" (40). However, a limitation arises from collecting the data at two points in time – no information is collected on events taking place in the years between baseline and follow-up that might affect the outcome under study. This, however, is most likely to be the case in the studies with the longest follow-up periods. Also, for all studies with the exception of three (12, 13, 31), baseline exposures are measured as point estimates, giving no information on duration of exposure.

With regards to occupational factors, most studies conceptualize and measure working conditions as individual exposures, while only a few, relatively recent studies have identified contextual exposures in terms of organizational level risk factors affecting duration of sickness absence (3, 41–43). An attempt to address interactions between individual and contextual levels with cluster samples was used in two studies (20, 29), where psychosocial factors were aggregated as workplace means. Using cluster samples and multilevel analysis opened up the possibility of simultaneously examining the effect of the individual and workplace level. Aggregated data are constructed by combining information at the lower level (of which the higher level is composed). Aggregated variables are merely summaries of the properties of lower level units and not measures of higher level properties. Besides aggregated

data, independent workplace level variables could be of scientific interest for future research designs. When using "workplace mean" in future research, it would be preferable to use workplaces of equal size to calculate the mean accurately.

Bias. In the case of the studies based on DWECS, selection bias can occur due to a non-response rate of 25% in the 2000 survey used for most studies. It could be that not all the subjects selected, completed and returned the questionnaires, and non-responders may have had a different work environment or health from those who replied.

Estimating the effect of work environment in a working population introduces some limitations due to the "healthy worker effect". However, this type of bias is eliminated as we only study persons under risk for sickness absence, censoring disability and old age pensioners, people who immigrate, and all others no longer under risk for sickness absence. Follow-up bias was limited when register data was used.

As the DREAM register entries on sickness absence compensation are based on employer claims for a refund, the entries do not necessarily reflect the "true" level of sickness absence from work. Employers have been known to forget to claim the compensation, which would underestimate the effects of the factors studied. However, according to Statistics Denmark, the registers reflect the 100% true levels of granted compensation for sickness absence, disability pension, and early retirement pension (www.dst.dk).

The two studies using the IPAW cohort are not representative of the working population in Denmark, but rather tend to represent occupational subgroups known to have an above-average level of absence. This could influence the balance between effects of psychosocial and physical risk factors, as these are unequally distributed between jobs, and the presented long-term sickness absence incidence estimates are not representative of the population in general.

Confounding. The studies also featured a broad array of potential confounders otherwise known to affect the outcomes under study. The selection of potential confounders was based on studies of relevant literature reviews, encompassing variables relating to age, gender, physical and psychosocial work environment, health behavior, family status, educational level, and employer characteristics. In the literature on the physical risk factors, no gold standard was found. Some studies adapted a broad understanding of physical work environment, additionally encompassing exposures to, for example, vibration and unpleasant temperature (44, 45). However, some residual confounding cannot be ruled out, as many workplace exposures were not measured.

Exposures. The psychosocial scales on decision authority, skill discretion, and social support from co-workers and supervisors derive from the Danish translation of the scales (46) developed for the Whitehall II study (47, 48). When reviewing the literature on occupational risk factors for sickness absence, consensus was found on these psychosocial measurements (49). The questions were transformed into indices and scales. All scales used for these studies were statistically validated, either in these studies or in previous studies (18, 19); the same applies for health behavior and employer characteristics. Baseline data were collected according to the best instrument available at the time of design of the study. Developments since then have led to new instruments exploring other, related, dimensions of the psychosocial work environment, originating from, for example, organizational justice (50) and effort–reward imbalance (51). A future challenge could be to explore the explanatory value of these measures in relation to health-related labor market transitions, such as sickness absence and return to work.

The physical risk factor measures in the work environment were also based on employee self-report, as opposed to other recent studies on physical work environment and sickness absence (52–54). This raises the discussion of so-called subjective and objective measures. The studies by Boedeker (53) and Trinkoff et al (54) differ in terms of measurement method, the latter was based on employees' self-reported assessment of exposure, whereas the former featured an external expert evaluation of exposures. In relation to this paper, the issue of subjectivity of the measurement of physical exposures is considered to be less relevant because of the longitudinal design allowing (employee-reported) exposure assessment before (register-recorded) onset of long-term sickness absence. While baseline measurements were questionnaire-based and register data were used to establish the outcome, the possible common method variance and the related positive bias is eliminated (55).

Measurement of sickness absence. Few studies specifically examine the problem of long-term sickness absence (4, 11, 56). In most studies in this paper, cases have had a sickness absence period of eight weeks or more. Eight weeks is a long period compared to the definitions of long- and short-term sickness absence used in other studies.

Only a few studies have been conducted on the quality of measurements used in occupational research (57–63), and, based on these studies, it seems that self-reported sickness absence data and employer recordings are equally useful when the recall period is less than two months. By using employer records, the problem of recall bias is eliminated. Nevertheless, any systematic recording

of non-illness-related absence as well as sickness absence in the lower grade, or under-recording in the higher grades, may introduce another source of bias.

Some studies (24, 27) address the fraction of sickness absence that can be attributed to work environment exposures and health behavior, respectively. Various types of attributable fractions can be calculated (ie, adjusted, sequential, and average attributable fractions) (64). Having multiple occupational exposures also allows for the adjusted attributable fractions to be calculated (25). This fraction is used as an indicator of the potential for reducing sickness absence through work environment improvement. The estimate of this potential is based on the assumption that everyone's work environment should be improved to the level of those 10% with the best work environment. Such an assumption is considered to be more theoretical than practical, and the indicated potential for sickness absence reduction is, therefore, also assumed to be more theoretical than practical.

All the studies used DREAM to establish the outcome. The use of register data also introduces a possibility of systematic over- or underestimation of sickness absence; the weekly information on transfer payments is registered if a person has received any kind of transfer payment for more than one day. This could lead to an overestimation of a single day on sickness absence compensation counting as an entire week. In contrast, there could be an underestimation of sickness absence as a whole, because companies may not report all sickness absence, especially short-term absence.

Measurement of return to work. In the return-to-work studies, people were assumed to have returned to work upon cessation of sickness absence benefit and subsequently not been receiving other social transfer benefits. The goal adopted in the area of research on return to work is generally achievement of an early and safe return to work. Unfortunately, the DREAM register does not provide this kind of data, thus introducing a limitation when constructing return-to-work outcomes. Factors that force sick-listed employees into a premature and unsafe return to work are not considered in this paper. It is important to consider that fear of losing one's job and financial strain will play a part in the employee's decision and can contribute to the decision of returning to work too soon and increasing the risk of re-injury and ill health (65). The outcome "time to return to work" has limited value and should always be supplemented with measures more inclusive of recurrences, supported by other measurements (ie, work ability index, work-role functioning, and quality of life).

Future challenges

Based on the findings presented in this paper and experience during the research process, we propose future directions for research in the following areas: (i) development of new measurements and cohorts specifically designed for sickness absence and research on return to work; (ii) development of new study designs (including legislative aspects) in order to estimate multiple levels of risk factors simultaneously; (iii) exploration of the effect of legislation on sickness absence rates across countries, using administrative data and multi-state designs (eg, comparing labor market transitions to the legislative context); (iv) further exploration of the effects of personality (eg, return to work self-efficacy, coping, and pain management) ; (v) study of relapse following return to work, in order to address the usefulness of cessation of sickness absence compensation as a return-to-work measure; and (vi) interventions on both physical *and* psychosocial work environment exposures in order to address long-term sickness absence reduction. Multilevel interventions to reduce sickness absence may be more effective if they address both the individual and organizational level of the workplace simultaneously.

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